



Opportunities for Additional Reductions from Petroleum Transportation Fuels

Workshop Summary

Petroleum in California

California produces

0.45%
of the world's oil



16,000 JOBS
in California's
petroleum industry

average annual salaries of
over \$70,000

Permitting oil & gas facilities

LOCAL & STATE GOVERNMENT



Permits Issued · 2008-2018

23,008 Re-abandon
Pour concrete and plug up

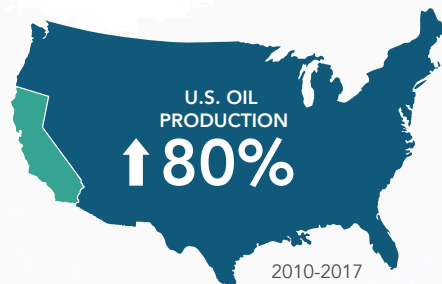
30,167 Drill
Majority replace inactive wells

27,621 Rework
Change or alter

99.4% of all permits issued are for wells located within existing fields

California oil production IS DECLINING

CALIFORNIA OIL
PRODUCTION
↓ 14%



California's In-state Production



Foreign oil imports are expected to
increase as in-state production decline



2014 – 2016

Petroleum Consumption IS INCREASING



OVERALL GHGs

DOWN 3%

↑ 4% OVERALL TRANSPORTATION EMISSIONS

State actions to reduce petroleum consumption 45% by 2030

- Double building efficiency
- 50% renewable power
- More clean, renewable fuels
- Cleaner zero or near-zero emission cars, trucks, and buses
- Walkable/Bikeable communities with transit
- Cleaner freight and goods movement
- Slash potent "super-pollutants" from dairies, landfills and refrigerants
- Cap emissions from transportation, industry, natural gas, and electricity
- Invest in communities to reduce emissions

Addressing local impacts

To better understand how oil and gas facilities and other pollution sources affect air quality in neighboring communities, the state is providing focused, community-level action in fourteen of the California's most polluted areas through AB 617 and Study of Neighborhood Air Near Petroleum Sources (SNAPS).



Source: CARB Opportunities for Additional GHG Reductions From Petroleum Transportation Fuels Workshop, August 2018

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On Monday, August 20, 2018, the California Air Resources Board (CARB or Board) convened a workshop to discuss opportunities for additional greenhouse gas (GHG) emission reductions from the production and consumption of petroleum transportation fuels. The workshop served as a forum to inform CARB's report to the Board later this year on progress towards implementing California's 2017 Climate Change Scoping Plan (Scoping Plan) to meet California's long-term GHG reduction goals including an assessment of new opportunities for further action in the transportation fuels sector.

The workshop included presentations by California agencies describing the policies and programs being implemented to reduce California's dependence on petroleum and transition to a lower-carbon, sustainable transportation system. Agencies also presented trends in the state's petroleum production and consumption over time. The workshop also provided a forum for technical experts to discuss additional opportunities to expedite efforts to reduce GHG emissions from the production and combustion of petroleum transportation fuels. While there are many important air quality and health benefits related to reduced usage of petroleum, the August 20 workshop, and subsequently this report, focus on GHG emission reductions.

This report synthesizes the workshop content and is organized as follows.

- Section 1 provides background information on the workshop;
- Section 2 presents the current California actions targeting GHG emissions in the transportation sector as summarized from workshop presentations by CARB and the Strategic Growth Council (SGC);
- Section 3 focuses on trends in petroleum production and consumption over time as presented by the California Energy Commission (CEC) and Department of Conservation (DOC);
- Section 4 discusses Resolution 17-46 of the Scoping Plan and two expert panel discussions on additional opportunities for GHG reductions from petroleum consumption and reduction opportunities from limiting the production of petroleum;
- Section 5 briefly outlines public comments received at the workshop; and
- Section 6 summarizes and provides recommendations for next steps.

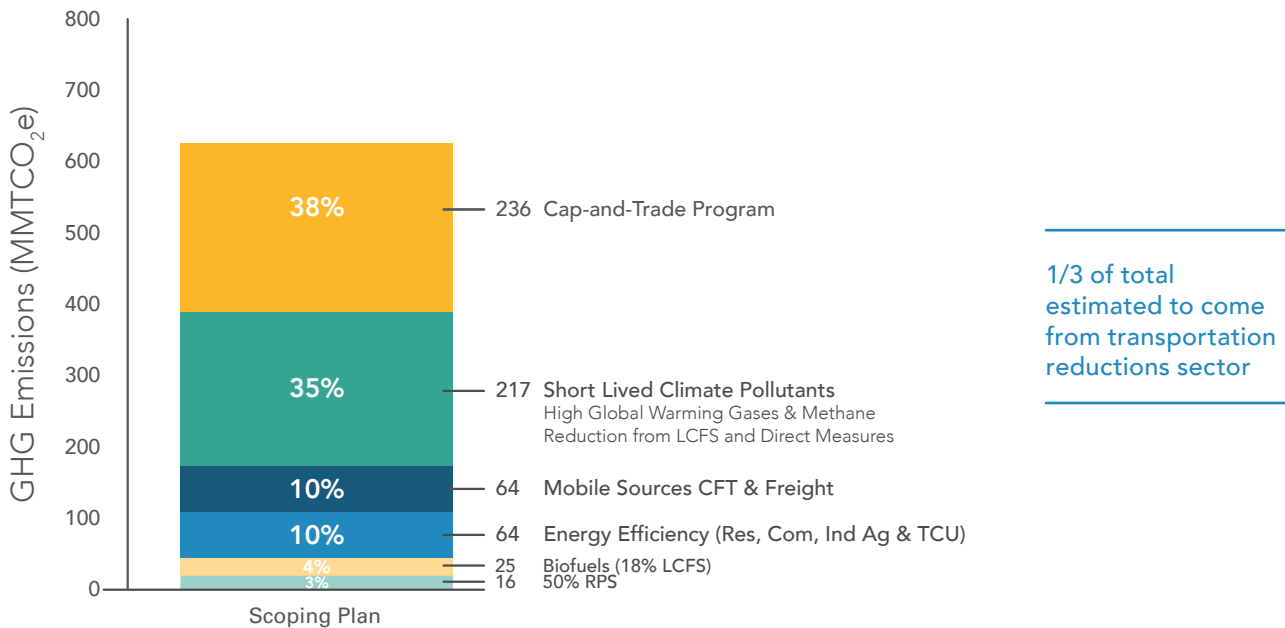
Section 1: Background Information

California’s transportation system underpins the state’s economy. The extensive freight system moves trillions of dollars of goods each year and supports nearly one-third of the state’s economy and more than 5 million jobs. The transportation sector is also the largest source of GHG, criteria, and toxic diesel particulate matter emissions in the state. When including upstream fossil fuel extraction and refining, the transportation sector accounts for half of California’s GHG emissions.

Given the magnitude of transportation emissions, achieving the state’s long-term climate and air quality goals requires significant GHG emission reductions in the sector. The Scoping Plan, approved by the Board in December 2017, outlines a path to achieving the Senate Bill 32 (SB 32) (Pavley, Chapter 249, Statutes of 2016), which will reduce GHG emissions 40 percent below 2020 levels by 2030. CARB’s analyses show that the measures outlined in the Scoping Plan will reduce fossil fuel demand by approximately 45 percent by 2030, dramatically reducing California’s dependence on petroleum transportation fuels.

The Scoping Plan outlines California’s comprehensive approach to reducing GHG emissions from the transportation sector which includes regulations, incentives, and investments that will promote a sustainable transportation system and economic growth. This approach addresses a full range of transportation system improvements relating to efficient land-use, affordable housing, infrastructure for cyclists and pedestrians, public transit, new vehicle technologies, fuels, and freight. As presented in Figure 1, an estimated one-third of GHG reductions needed to achieve the 2030 target are anticipated to come from the transportation sector.

FIGURE 1. CALIFORNIA’S 2017 CLIMATE CHANGE SCOPING PLAN CUMULATIVE REDUCTIONS (2021-2030) NEEDED TO ACHIEVE THE 2030 TARGET



California’s current comprehensive approach to transportation emissions is already paying dividends and remarkable progress has been made over the past 10 years, putting the global energy and transportation sector on a transformative path to cleaner energy. Electric vehicle battery costs have fallen quickly, even more quickly than solar costs which have far outpaced expectations, while performance has improved dramatically. California’s transportation policies have also created markets for energy efficient technologies, energy storage, low-carbon fuels, renewable power, and zero-emission vehicles (ZEVs).

California companies are thriving, making advanced low-carbon technology markets grow. California is home to nearly half of the zero-emission vehicles in the United States and 40 percent of North American clean fuels investments. California is further advancing efficient land-use policies that reduce auto dependency. And, the state has committed to investing billions in zero-emission vehicles and infrastructure, land-use planning, and active transportation options such as walking and biking. But despite this progress, transportation sector GHG emissions have increased as the California population has grown and economic conditions have improved while fuel prices have remained low.

The 2016 GHG inventory, released by CARB in July of 2018, shows that California's overall GHG emissions are declining. In 2016, emissions were 12 million metric tons of carbon dioxide equivalent (MMT CO_2e) lower than 2015 levels and 2 MMT CO_2e below the 1990 level and the state's 2020 GHG target. As presented in Figure 2, per capita GHG emissions are also declining. From 2000 through 2016, per capita GHG emissions in California dropped 23 percent.

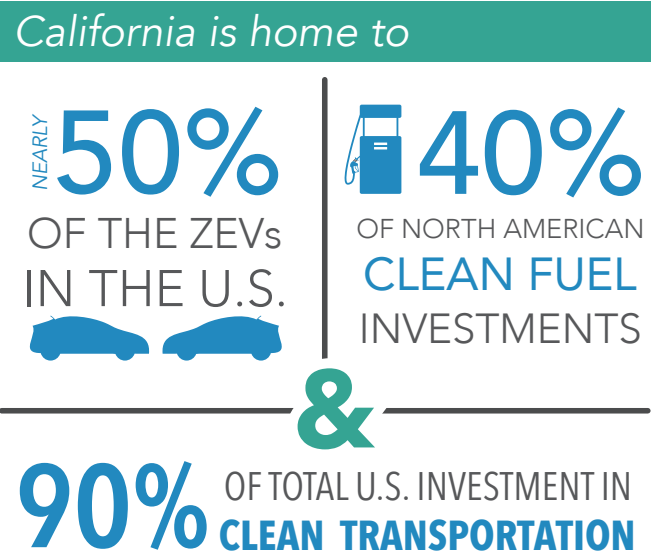
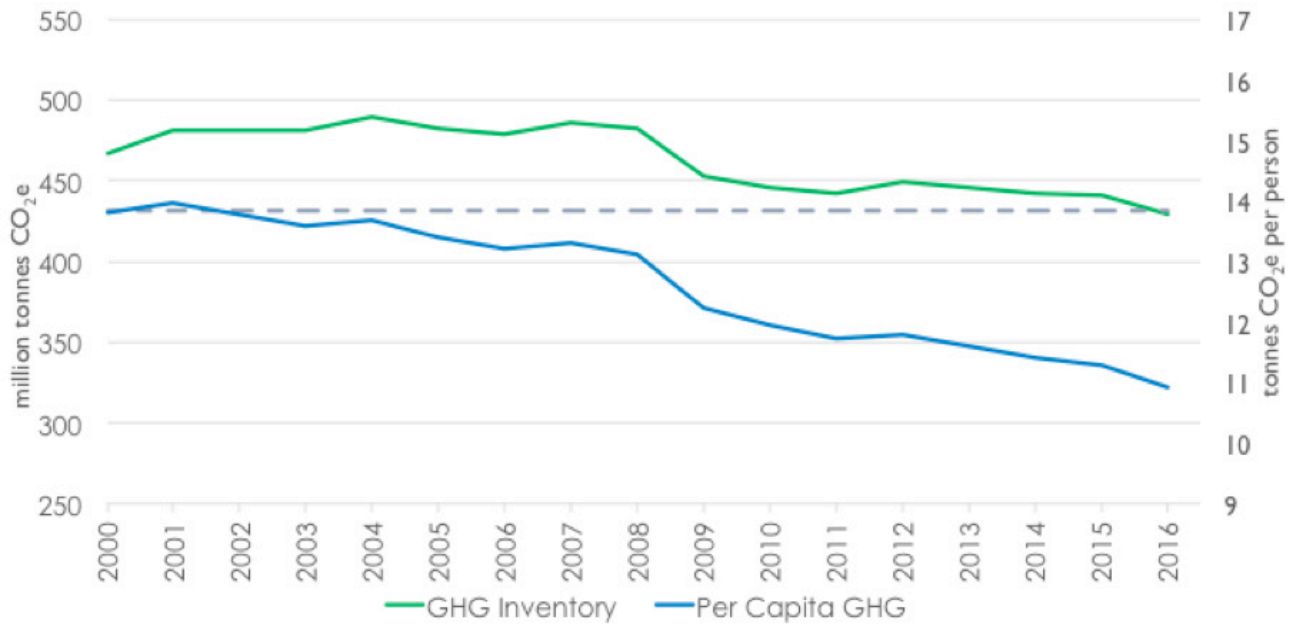
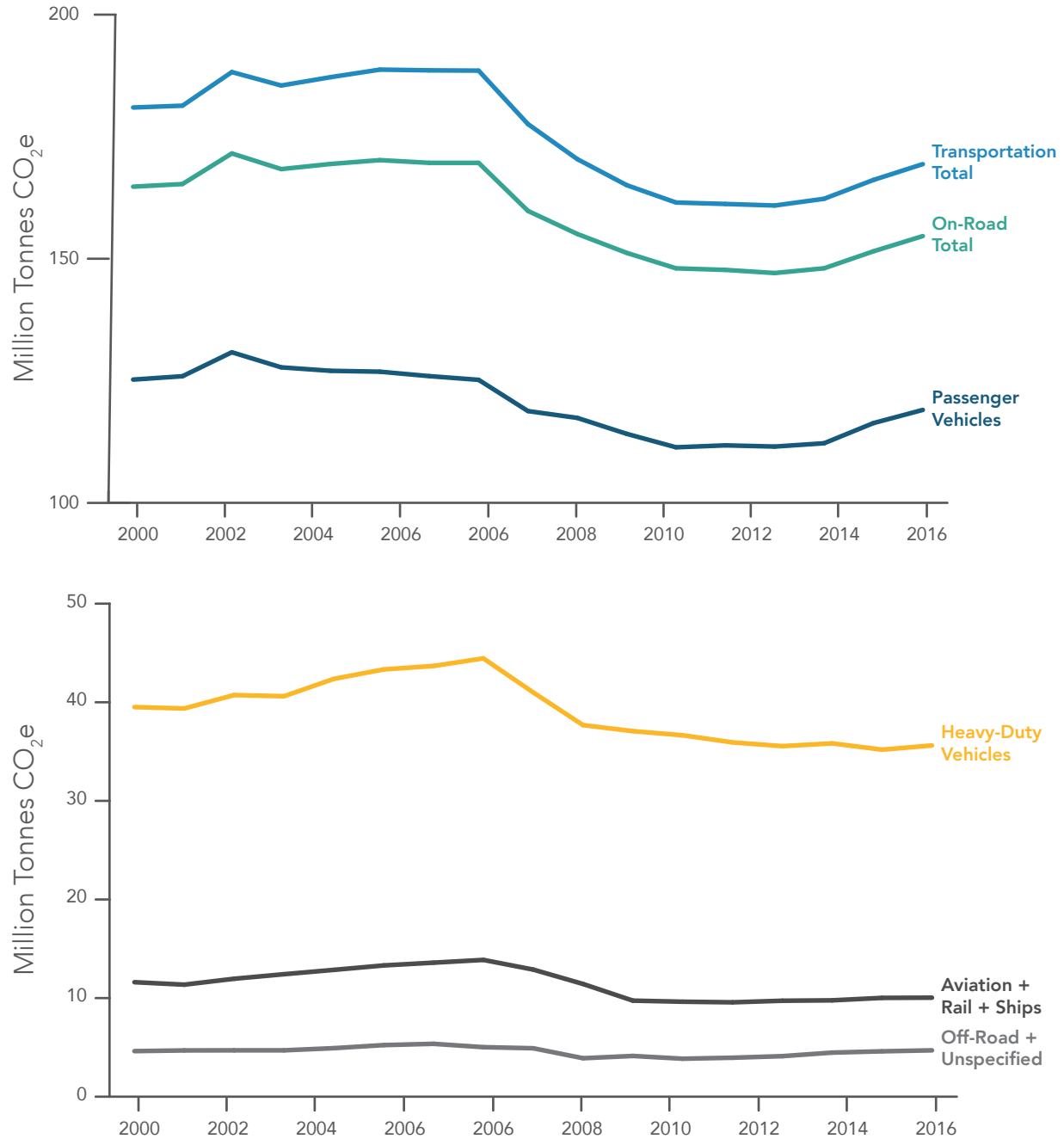


FIGURE 2: CALIFORNIA GHG INVENTORY AND PER CAPITA GHG EMISSIONS



While overall emissions are declining, GHG emissions from the transportation sector increased by 4 percent from 2014 to 2016, driven primarily by gasoline used in on-road vehicles. Figure 3 presents the transportation sector GHG emissions from 2000 through 2016.

FIGURE 3. TRANSPORTATION SECTOR GHG EMISSIONS, 2000 TO 2016



Given the upward trend in emissions from on-road petroleum transportation fuels, the August 20 workshop provided an opportunity to discuss the strategies currently being implemented in California to reduce GHG emissions in the sector and discuss potential opportunities for additional GHG emission reductions from the usage of petroleum fuels. This is consistent with the Scoping Plan which recognizes the importance of continuing to evaluate GHG reduction opportunities, both in the face of weakening federal standards and in pursuing new cost-effective and technologically feasible policies. In Resolution 17-46, the Board directs CARB to continue to explore opportunities to achieve significant cuts in GHG emissions from all sources – including supply-side opportunities to reduce production of energy sources. Resolution 17-46 is further discussed in Section 4.

Section 2: Current actions to reduce GHG emissions in the transportation sector

California's comprehensive strategy for GHG reductions in the transportation sector includes policies and programs to reduce petroleum demand and transition the state to a sustainable transportation system. As outlined in the Scoping Plan and Mobile Source Strategy, the state will reduce GHG emissions in the transportation sector by implementing policies and programs to achieve the following high-level objectives and goals:

Vehicle Technology Goals

- Reach 100 percent ZEV sales in the light-duty sector by 2050
- Make significant progress in ZEV penetrations in non-light-duty sectors

Clean Fuel Goals

- Electrify the transportation sector using both electricity and hydrogen
- Rapidly reduce carbon intensity of existing liquid and gaseous transportation fuels

Sustainable Freight Goals

- Increase the freight system efficiency of operations such that carbon can be moved with fewer emissions
- Accelerate use of clean vehicle and equipment technologies and fuels through introduction of zero emission or near-zero-emission (ZE/NZE) technologies and continued development of renewable fuels

Vibrant Communities and Landscapes

- Promote all feasible policies to reduce vehicle miles traveled (VMT) including land-use and community design and transit-oriented development
- Complete the construction of high-speed rail integrated with enhanced rail and transit systems throughout the state
- Increase biking and walking

The transportation sector has considerable influence on other sectors and industries in the state. California's transportation sector is still primarily powered by petroleum and, to reduce statewide emissions, California must reduce demand for driving; continue to reduce its gasoline and diesel fuel consumption; diversify its transportation fuel sources by increasing the adoption of low- and zero-carbon fuels; increase the ease and integration of the rail and transit networks to shift travel mode; and deploy ZE/NZE vehicles.

As California's population continues to increase, land-use patterns will directly impact GHG emissions from the transportation sector, as well as those associated with the conversion and development of previously undeveloped land. Specifically, where and how the state's population grows will have implications on distances traveled and tailpipe take out; as well as on secondary emissions from the transportation sector. This includes emissions from vehicle manufacturing and distribution, fuel refining and distribution, demand for new infrastructure (including roads, transit, and active transportation infrastructure), and demand for maintenance and upkeep of existing infrastructure.

CARB is the leading California agency implementing GHG reduction measures in the transportation sector that impact vehicles, fuels, and infrastructure. CARB implements a number of programs that address light-duty vehicle sector emissions including the Advanced Clean Cars suite of regulations that implement GHG and criteria emission fleet standards and California's Zero-emission Vehicle (ZEV) Mandate. CARB also manages the Low-Carbon Transportation program that includes the Clean Vehicle Rebate Program (CVRP), the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) which provides incentives for hybrid, zero-emission, and low-NO_x technologies for trucks and buses, as well as electric vehicle car sharing pilot projects.

To expand mobility options and reduce vehicle travel needs, CARB also leads the SB 375 Sustainable Community Strategy program and engages with other agencies on active transportation and transit planning including SGC, which coordinates the activities of state agencies and stakeholders to promote sustainability, economic prosperity, and quality of life for all Californians. To that end, SGC investment programs including the Transformative Climate Communities and Affordable Housing and Sustainable Communities (AHSC) programs, which fund affordable housing units, reduce California's dependency on vehicles, and deliver GHG emission reductions. The AHSC program funds infill projects to reduce VMT through sustainable land-use, housing, and transportation practices. To date, 79 AHSC projects have resulted in over \$697 million on

investments funding over 6,200 affordable housing units, reducing vehicle dependency by 11,600 cars and reducing GHG emissions by 1.6 MMTCO₂e.

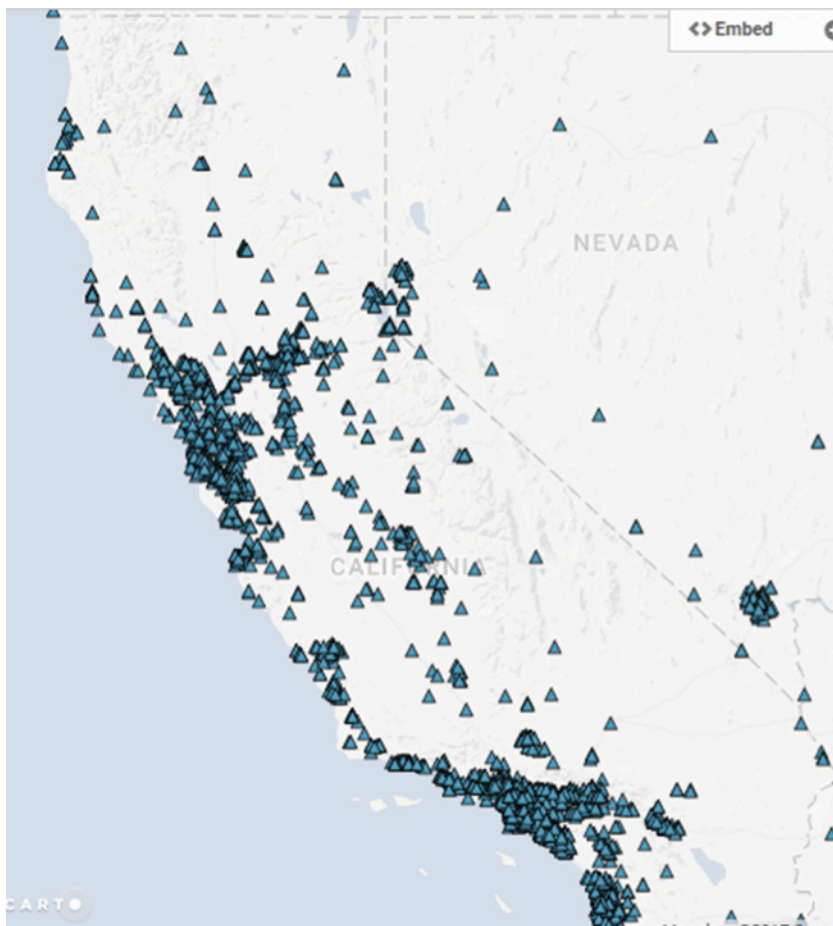
CARB also has a number of programs to address emissions from the production and combustion of fuels, including the Low-Carbon Fuel Standard (LCFS), the Oil and Gas Regulation, and the Cap-and-Trade Program. The LCFS is one of the key Assembly Bill 32 (AB 32) (Nunez, Chapter 488, Statutes of 2006), measures designed to reduce GHG emissions in California, but it also has other significant benefits, including transforming and diversifying the fuel pool in California to reduce petroleum dependency and achieve air quality benefits, which are state priorities that preceded AB 32. The LCFS is well positioned to be a critical part of the portfolio of California's GHG reduction measures through 2030. The LCFS was approved in 2009 and has reduced the carbon intensity of California's pool of transportation fuels by 3.5 percent and is on track to a planned 10 percent reduction by 2020. Although implementation of the LCFS has gone well, there are opportunities to improve the regulation. Current amendments to the LCFS include proposals to strengthen the program's carbon intensity targets – to a 20 percent reduction in carbon intensity by 2030. If approved, the amendments would smooth the carbon intensity trajectory post 2018 and result in an adjusted carbon intensity reduction of 7.5 percent by 2020.¹

GHG emissions from the production and combustion of transportation fuels are also covered under the Cap-and-Trade Program. Fuels covered under the Program include gasoline, diesel, propane, and natural gas - and also include imported fuels. In-state processing and combustion emissions at refineries in the oil and gas sector are also covered by the Cap-and-Trade Program. Regulated entities must reduce on-site emissions, supply lower carbon fuels, and/or purchase compliance instruments to cover their GHG emissions. The Cap-and-Trade Program creates incentives to invest in cleaner fuels and use energy more efficiently in California and beyond.

The Oil and Gas Regulation reduces in-state fugitive and vented emissions of methane upstream of transportation fuel production, from oil and gas facilities. Covered facilities include oil and gas production, processing, and storage, natural gas gathering and boosting stations, as well as natural gas underground storage and transmission compressor stations. The Oil and Gas Regulation is estimated to result in reductions of more than 1.4 MMTCO₂e per year which represents a methane reduction of over 40 percent from the oil and gas sector by 2021.

Additional GHG reductions are also anticipated from the ZEV fuel infrastructure planning initiatives and support for hydrogen and EV charging stations. Today in California, there are over 15,000 public electric vehicle (EV) chargers of varying power levels, and 35 retail-open hydrogen stations. With the current programs adopted, the state estimates over 100,000 EV chargers and 100 hydrogen stations will be in place by 2025. However, the Governor's 2018 Executive Order B-48-18 outlines the need to go further on infrastructure with a \$2.5 billion pledge to bring 250,000 EV chargers and 200 hydrogen fueling stations to California by 2025. Today, there are over 15,800 electric vehicle chargers in California as depicted in this map.

CALIFORNIA EV CHARGING LOCATIONS



¹ <https://www.arb.ca.gov/regact/2018/lcfs18/isor.pdf>

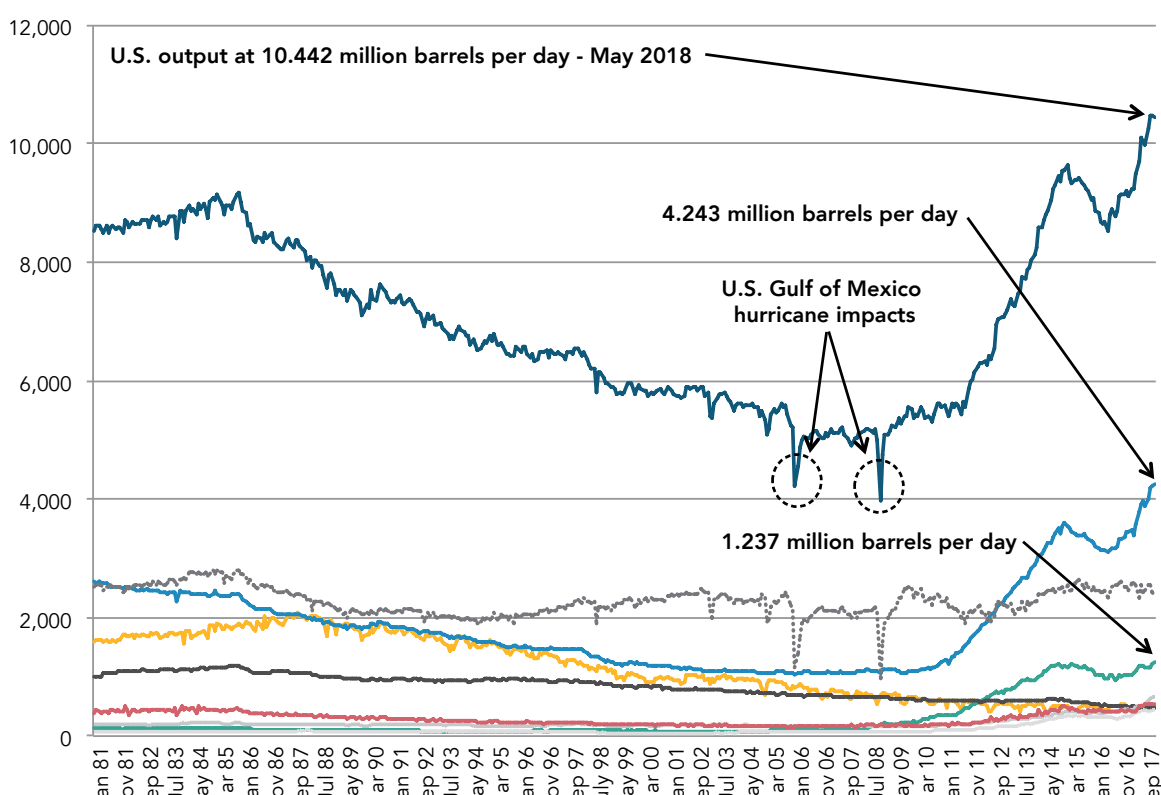
By continuing to implement a comprehensive strategy, California can work to ensure the continued penetration of zero- and near-zero-emission technologies and increase the use of clean, low-carbon fuels. Local transportation planning can make communities become healthier and more vibrant and connected – encouraging housing, walking, biking and transit policies that reduce GHG emissions and promote good quality of life. Statewide planning can ensure that our systems that connect regions and communities provide efficient, low-carbon transport options. And, California can work to ensure that an efficient sustainable freight system continues to power our economy as we achieve our long-term targets. Key to achieving our long-term climate and air quality targets is a continued reduction in the demand for petroleum-based transportation fuels, discussed in more detail in the next section.

Section 3: The State of California's Petroleum Production and Consumption

California is the most populated state in the nation, and, with the largest economy, our total energy demand is second only to Texas. Although California is a leader in many energy-intensive industries, the state has one of the lowest per capita total energy consumption levels in the country, second only to Hawaii.²

The United States is the world's leading producer and consumer of oil, supplying 15 percent of the world's oil and consuming 20 percent of world supplies in 2017.³ Within the U.S., California is the fourth largest producer of oil, behind Texas, North Dakota, and Alaska.⁴ Outside of California, U.S. oil production increased 136 percent from 2007 to 2017, while California production declined by 28 percent over the same period. The growth in U.S. production is primarily due to expanded development of shale oil deposits, steadily improving drilling efficiency, and more cost-effective drilling technology. California did not see a similar rebound in oil production, as shown in Figure 4, largely due to the state's declining production trends and the fact that the majority of economic oil and gas deposits have already been developed.

FIGURE 4: CALIFORNIA AND NON-CALIFORNIA OIL PRODUCTION, 1981 TO 2017



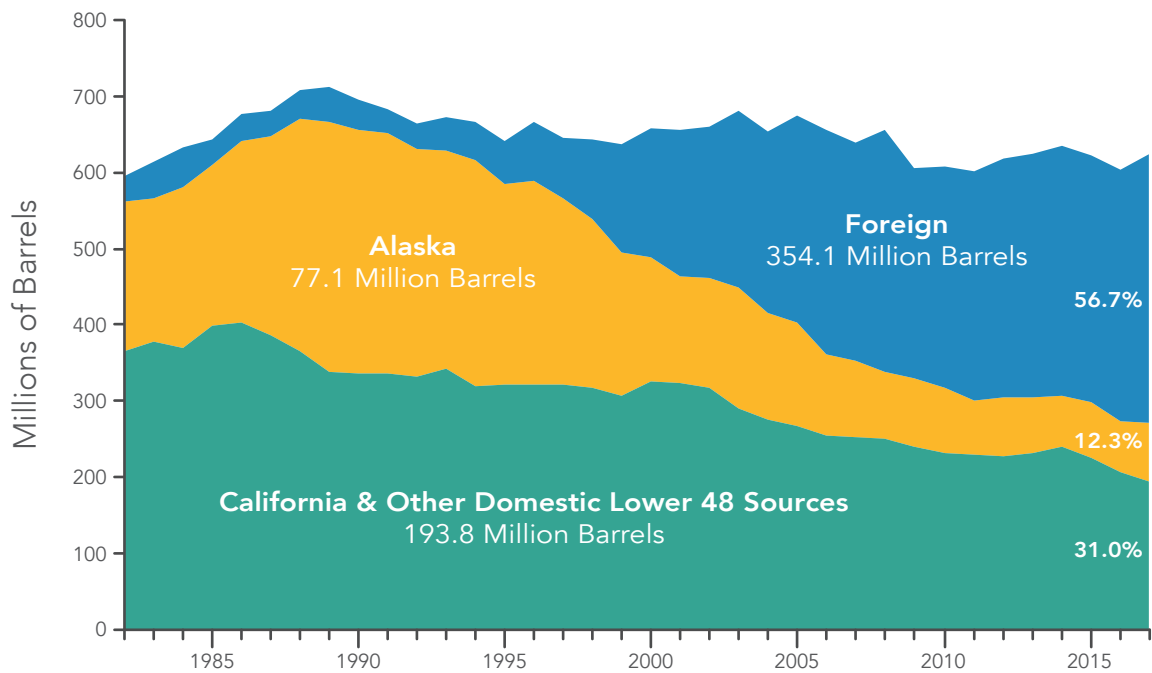
The continued decline of both California and Alaska crude oil production has resulted in an increase in foreign oil imports by California refineries. In 2017, California refineries processed 1.7 million barrels of oil a day. Imports of foreign oil are expected to increase as California's production continues to decline. Figure 5 presents the origin of California oil over the period 1982 to 2017.

² U.S. EIA, State Energy Consumption Estimates, 1960 through 2015, DOE/EIA-0214(2015) (June 2017), Table C13, Energy Consumption per Capita by End-Use Sector, Ranked by State, 2015.

³ <https://www.eia.gov/tools/faqs/faq.php?id=709&t=6>

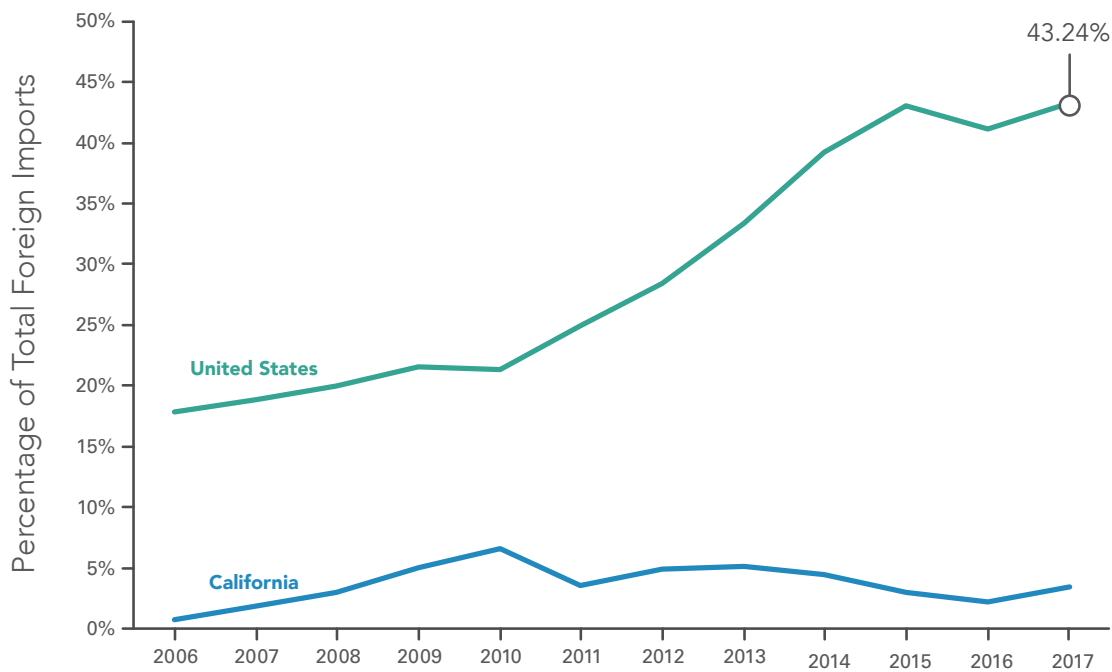
⁴ https://www.eia.gov/energyexplained/index.php?page=oil_where

FIGURE 5: CALIFORNIA REFINERY OIL SOURCES, 1982 TO 2017



In addition, California refiners have been decreasing their use of Canadian crude oils. This trend is contrary to the national trend in which states outside of California are increasing their consumption of Canadian oil, as shown in Figure 6.

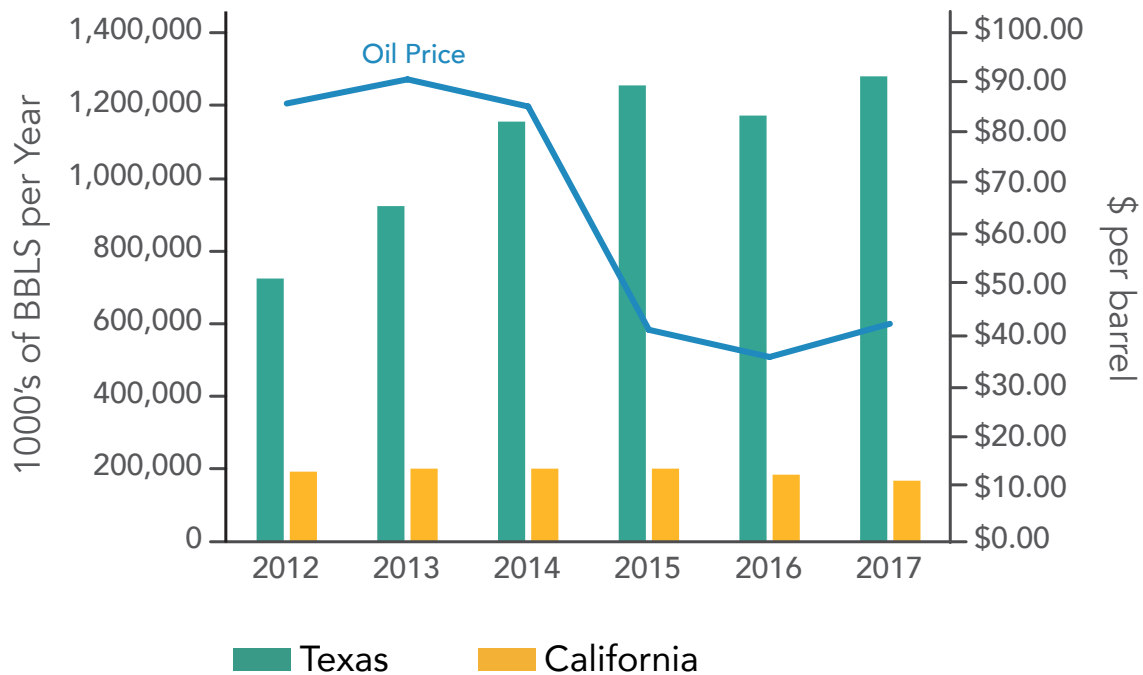
FIGURE 6: CANADIAN CRUDE OIL IMPORTS INTO CALIFORNIA, 2006 TO 2016



Unlike other states, in recent years oil production in California has not been price responsive. As outlined in Figure 7, since 2012, oil production in California has not been strongly correlated with the price of oil. This is not a trend in other states, notably Texas, where oil production increases as the price of oil increases. In states like Texas where new oil fields continue to become economically viable for production, high oil prices can lead to increased exploration and increased production. However, in states with declining economically viable reserves, like California, production may not be as responsive to price. Additionally, California’s climate

policies are designed to increase in stringency over time and are combined with incentives for non-fossil-fuel transportation alternatives to affect consumer choices and the market. These measures help to drive the continued decline in production in California.

FIGURE 7: CALIFORNIA AND TEXAS OIL PRODUCTION AND OIL PRICE, 2012 TO 2017

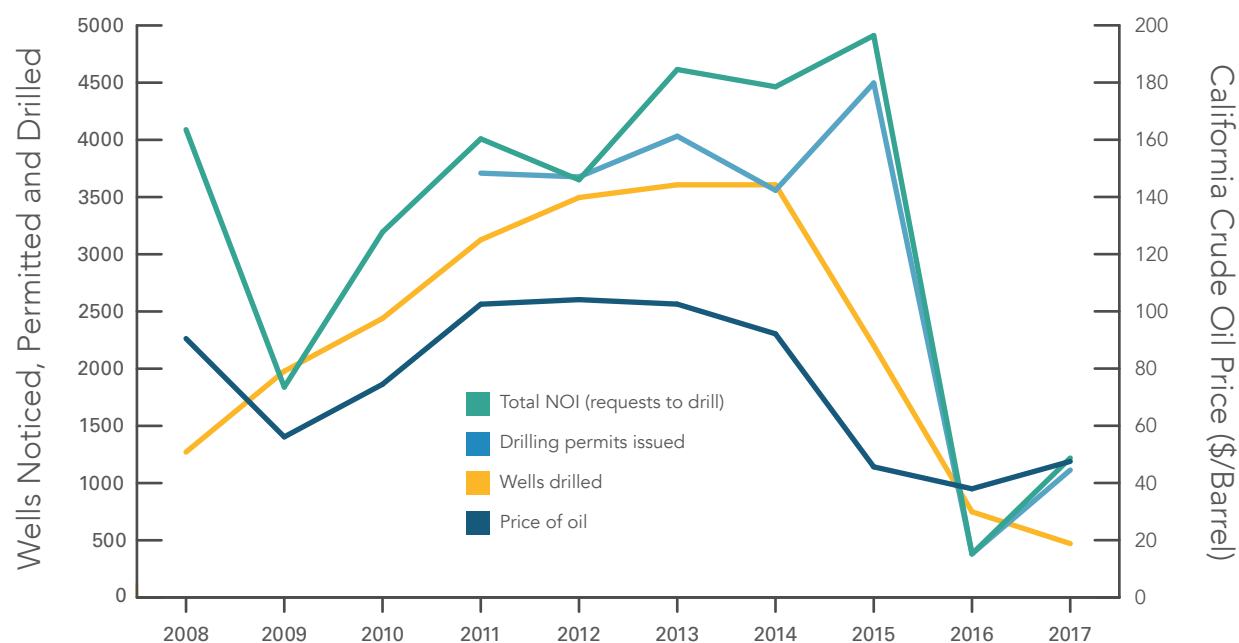


All California oil and gas operations are regulated by the Department of Conservation’s Division of Oil, Gas, and Geothermal Resources (DOGGR). Individual well activities, such as drilling a new well, reworking an existing well, and plugging abandoned wells within oil and gas fields all require a notice of intent (NOI) to be approved by DOGGR. Local land-use approval for oil field operations must be secured by oil and gas operators from the city or county in which operations will occur before DOGGR can issue a permit to drill a well. Drilling permits are valid for up to two years.

While oil production in California is not very price responsive, the number of drilling permits issued per year varies, corresponding largely to the fluctuations of the price per barrel of oil. Additional variation in drilling permits may be due to the fact that oil and gas operations have up to two years to execute on a permit. Therefore, there are some years when the number of drills permitted exceeds the number of well actually drilled.

As presented in Figure 8, the number of drilling permits issued in California is correlated with the price of oil. For example, in 2013, when the average price per barrel of oil was \$102.53; the number of new wells drilled was 3,607. However, in 2017, the average price per barrel of oil was \$47.55 and there were 471 new wells drilled.

FIGURE 8: CALIFORNIA DRILLING PERMITS, 2008 TO 2017



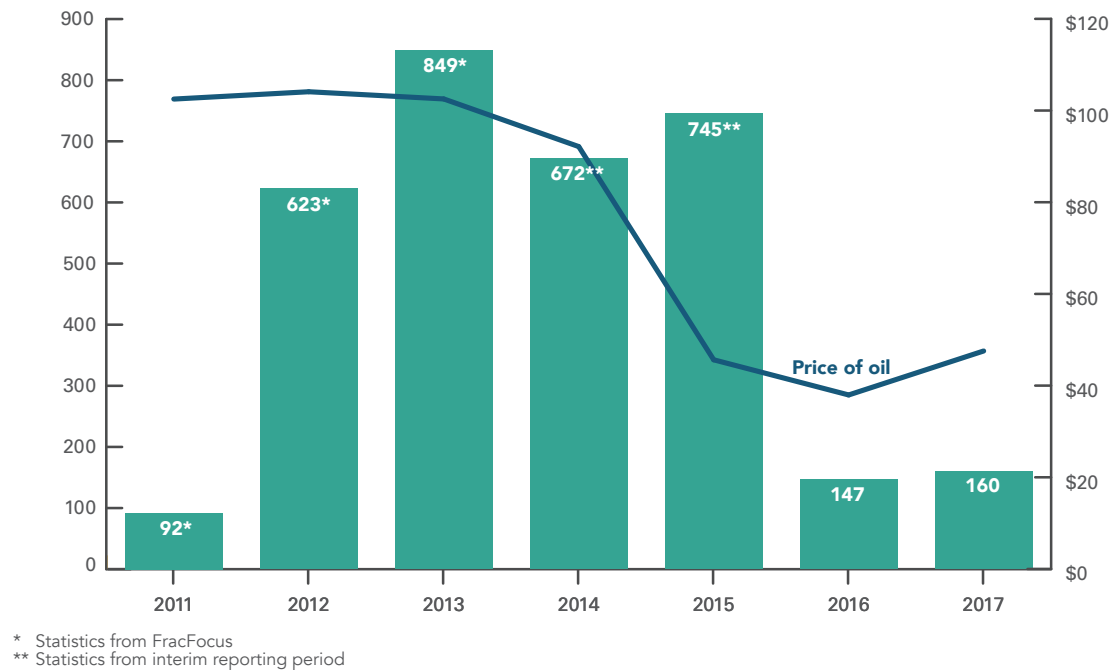
Well stimulation treatments, including hydraulic fracturing (also known as fracking) also require a permit and approval by DOGGR. Well stimulation is a completion technique performed on an oil or gas well to increase production.

Since January 2014, California has implemented a comprehensive regulatory program on hydraulic fracturing that includes the following elements:

- Hydraulic fracturing must be permitted by DOGGR and reviewed by the State Water Resources Control Board to determine whether groundwater monitoring is required;
- Approval to conduct hydraulic fracturing is contingent upon an extensive engineering review and well integrity evaluation in order to ensure the fractures are confined to the intended geologic zone;
- Neighboring parties (within 1500 feet) must receive advance notification of projects and can request their water quality be tested to establish a baseline;
- The volumes and concentrations of chemicals used in the process must be disclosed;
- Comprehensive post-stimulation reports must be filed, including the amount of water used and the source of that water; and
- Seismic monitoring must take place during well stimulation operations.
- DOGGR has developed a website to facilitate public disclosure of well stimulation projects and to allow the public to easily search and aggregate this information.

Hydraulic fracturing is a technique that works in certain types of geologic formations and is employed in only a handful of the many existing oil fields in the state. The number of hydraulic fracturing permits in California also corresponds with the price per barrel of oil, with higher oil prices resulting in an increase in permits. For example, in 2013, when the average price per barrel of oil was \$102.53, the number of hydraulic fracturing operations (prior to the requirement of permits) executed was 849. However, in 2017, when the average price per barrel of oil was \$47.55, the number of executed hydraulic fracturing permits was 160. Figure 9 demonstrates this trend.

FIGURE 9: CALIFORNIA WELL STIMULATION, 2011 TO 2017



Oil and gas wells are located throughout California. Figure 10 outlines the location of active wells in California as well as the location of the active drilling permits. From 2011 through 2017, DOGGR approved 23,167 well permits. Over 99 percent of these wells (22,992) were in existing oil fields that were established and in operation prior to 2011. Of the remaining 175 well permits, 146 were canceled and 29 were executed upon. As shown in Figure 10, most of the 29 well permits are neighboring existing oil and gas field boundaries. It is important to note that although there are many permit actions each year, California production has been declining since the mid-1980s.

FIGURE 10: PERMITTING AND OIL OPERATIONS LOCATIONS IN CALIFORNIA

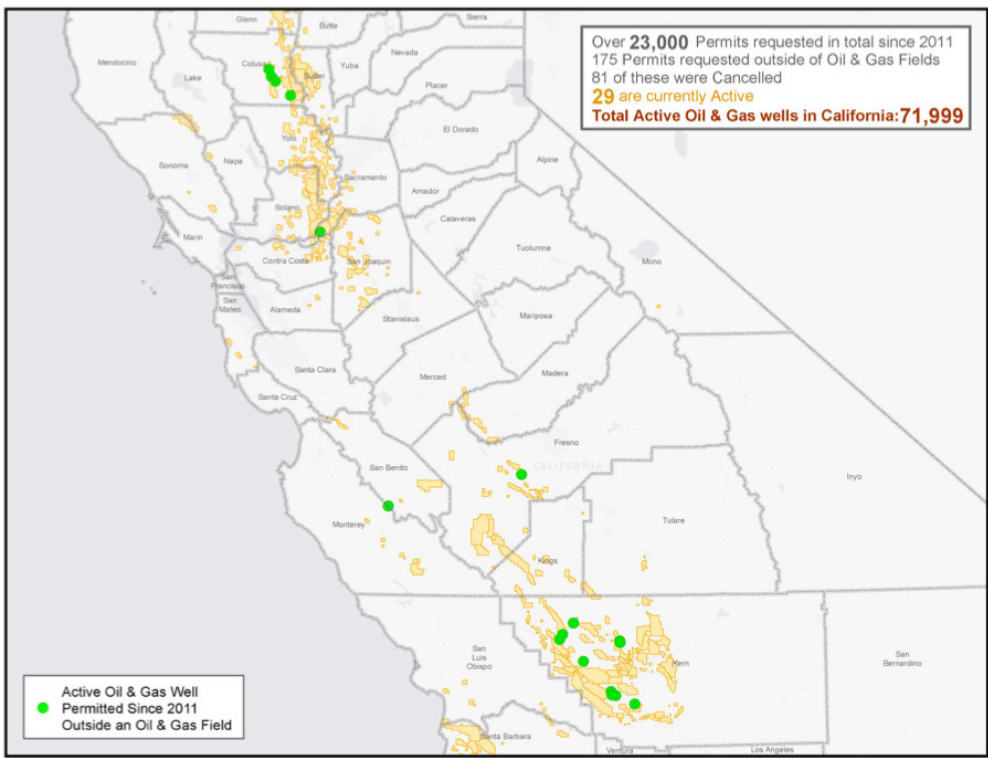
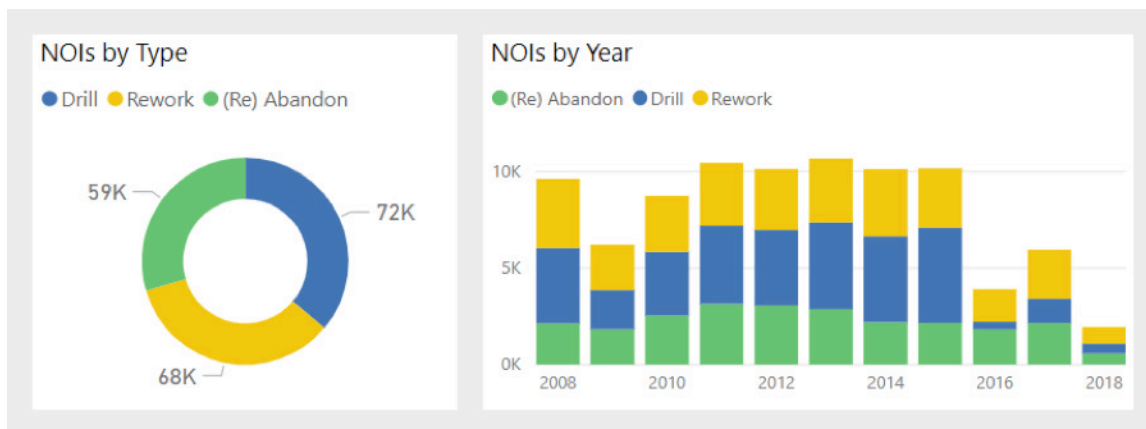


Figure 11 provides additional detail on the types of well permits issued from 2008 to 2018. Over this period, there were nearly as many well permits issued to plug abandoned wells (53,966) as there were new well drills (64,735). This further demonstrates that the vast majority of new well permits are primarily to maintain steady statewide production declines.

FIGURE 11: NOTICE OF INTENT BY TYPE OF PERMIT, 2008 TO 2018



As communities living near oil and gas facilities have increasingly expressed public health concerns, in addition to local air regulations and annual inspections, CARB has developed a suite of strategies to reduce criteria air pollutants and air toxics near oil and gas facilities at the community level. Assembly Bill 617 (AB 617) (C.Garcia, Chapter 136, Statutes of 2017) provides a community-focused action framework to improve air quality and reduce exposure to criteria air pollutants and toxic air contaminants in communities most impacted by air pollution, including those near oil production facilities. AB 617 requires additional community-level emissions and exposure reduction strategies to improve air quality and reduce exposure to criteria air pollutants and toxic air contaminants in communities most impacted by air pollution. AB 617 requires stationary sources, including oil and gas facilities and refineries, to monitor and report air pollution and toxic emissions data.⁵ AB 617 also requires air districts to make determinations for best available control technology (BACT) and requires new emissions accounting through a centralized database that will result in revised best available control technology for toxic air contaminants (T-BACT) for new sources that reflect the most stringent limits and expedite the installation of best available retrofit control technology (BARCT) at industrial stationary facilities.

CARB is also developing the Study of Neighborhood Air Near Petroleum Sources (SNAPS) program to study air quality in communities near oil and gas facilities, particularly production facilities. As part of SNAPS, air monitoring trailers will be placed in selected communities to assess air quality to help CARB learn more about potential impacts of criteria pollutants and toxic air contaminants in neighborhoods near oil and gas activities.

5 https://ww2.arb.ca.gov/sites/default/files/2018-02/capp_concept_paper_february_2018.pdf

Section 4: Additional Opportunities for GHG Reductions

In December 2017, the Board approved California's 2017 Climate Change Scoping Plan including the suite of policies and programs to achieve the 2030 GHG target. The Board also acknowledged the need to continue to seek out new GHG reductions and through Resolution 17-46 directs:

The Executive Officer to continue to evaluate and explore opportunities to achieve significant cuts in greenhouse gas emissions from all sources, including supply-side opportunities to reduce production of energy sources, that contribute to climate change, air pollution, and other environmental health hazards. The Executive Officer will update the Board by December 31, 2018 and annually thereafter, and pursue measures that are cost-effective and technologically feasible.⁶

In response to Resolution 17-46 at the August 20 workshop, CARB convened two technical panels to discuss additional opportunities for GHG reductions from petroleum consumption and examine options to limit production of petroleum for additional GHG reductions. The two panels were moderated by CARB and included a discussion of technical experts in economics, petroleum markets, and transportation policy.

Panelists were encouraged to discuss opportunities for additional GHG reductions based on their expertise on issues related to petroleum consumption (panel 1) and limits on petroleum production (panel 2) and also respond to questions from the moderator and members of the workshop audience. Summaries of the panel discussions are provided below.

Panel 1: Opportunities for Additional GHG Reductions from Petroleum Consumption

Panel 1 Experts:⁷

- Christopher Knittel, Massachusetts Institute of Technology
- Ashley Langer, University of Arizona
- Hannah Pitt, Rhodium Group
- Dan Sperling, UC Davis and CARB Board Member

Panel 1 included an overview of California's comprehensive set of policies to reduce GHG emissions in the transportation sector and the need to fully implement our programs in the face of federal policy uncertainty. Panelists discussed the role of new policies on GHG emissions including the role of autonomous vehicles, rebates and incentives for clean vehicles, congestion pricing, and different forms of VMT pricing.

While panel 1 highlighted the need for innovation to reduce GHG emissions further in the transportation sector, there was no consensus on specific policy or technology recommendations within the context of Resolution 17-46. The discussion underscores the need to think broadly about the impact of all sectors and land-use decisions on transportation emissions as well as the need to better incentivize innovation and technology development in the sector.

The panel 1 discussion focused on the need to address the two components of GHG emissions in transportation: (1) emissions of the vehicle fleet and (2) the number of vehicle miles traveled. In addressing the key components of transportation emissions and additional policies and technology options to further reduce GHG emissions from petroleum consumption, the panel discussion focused on the questions presented below, which are followed by a summary of the panel discussion in response to the question.

How can California best address the emissions of our vehicle fleet?

Providing a wide range of zero-emission mobility options, including vehicles, transit, ride-sharing, pooling, and autonomous vehicles, is critical to reducing GHG emissions in transportation. Current subsidies for ZEVs are necessary for penetration but California needs to consider the overall GHG impact of state-level programs with federal and local policies and the potential impacts of new technologies including autonomous vehicles.

⁶ <https://www.arb.ca.gov/board/res/2017/res17-46.pdf>

⁷ Short biographies of the panel experts are available at:
<https://www.arb.ca.gov/cc/scopingplan/meetings/082018/panelist-biographies-august-20-2018-ghg-workshop.pdf>

How can California reduce vehicle miles traveled?

California needs to think comprehensively about GHG reductions. Transportation emissions are also affected by land-use and housing decisions made at the local and regional level. When designing new policies, California should consider the impact of reducing the cost of zero-emission mobility options on VMT, including the impact of ride-sharing and autonomous vehicles on overall GHG emissions.

What new policies can California implement to reduce GHG emissions from the transportation sector?

California already has a comprehensive suite of policies to reduce GHG emissions and air pollution in the transportation sector. When considering new policies, it is important to understand the market failure, where resources are distributed inefficiently – that is leading to a need to achieve additional GHG reductions. The externalities of GHG emissions is addressed through carbon pricing, but there may be a need to better incentivize innovation, and reduce the initial technology costs associated with batteries and other zero-emission transportation. Providing regulatory certainty and promoting consumer awareness is also critical to ensuring that any new policy will be successful. Any new policies should work to improve the overall lives of Californians – including ease of mobility, access to employment opportunities, and improved health outcomes.

While California represents one percent of global GHG emissions, the state has have a role as a leader in policies that can be adopted in other states and around the globe. New transportation polices that can be exported are critical in achieving deep global GHG emission reductions.

What are the next steps for California in reducing GHG emissions?

Reducing battery costs is key to transforming the transportation sector and achieving penetration in ZEVs. California must incentivize innovation to lead to technological breakthroughs. In addition, looking across all sectors of the economy – including land-use and housing – should also be considered as California moves forward in designing new policies. Ensuring wide access to clean vehicle technologies across all populations in California also needs to be a fundamental piece of any new policy development. In addition, California must prioritize transportation funding to ensure our investments support our climate, clean air, health, conservation, and equity goals.

Panel 2: Examining Options to Limit Production of Petroleum for Additional GHG Reductions

Panel 2 Experts:

- Roger Aines, Lawrence Livermore National Laboratory
- Severin Borenstein, UC Berkeley
- Peter Erickson, Stockholm Environment Institute
- Amy Myers Jaffe, Council on Foreign Relations

Panel 2 included a detailed description of policy recommendations to limit the production of petroleum in California, including a moratorium on new well permits, as well as the economic implications of restricting California petroleum supply on the global oil market. The panel also included a discussion of the opportunities for GHG reductions from carbon capture and storage and innovative zero-emissions technologies in petroleum extraction. The discussion focused on the uncertainty and complexity – economic, technological, and political - inherent in the global oil market and the need to consider the various impacts of restricted production across a range of jurisdictions including local, state, and global levels. Commenters and panelists also highlighted the need to consider the environmental justice impacts of any reduction in petroleum production, including air quality impacts, as well as impacts on fuel prices and employment opportunities.

Similarly to the first panel, panel 2 discussed the need for innovation and research, development, and demonstration for market penetration of new technologies like carbon capture and storage (CCS) to reduce GHG emissions further in the transportation sector. There was no consensus on specific policy or technology recommendations for immediate implementation within the context of Resolution 17-46. However, the panel did agree that additional discussions related to the potential implications of any policy to reduce California oil production are needed. In addition, panelists discussed the need to analyze any policy to restrict petroleum

production in the context of California's existing suite of Scoping Plan measures to ensure potential reductions would be additional and could be achieved at costs that would not adversely impact the California economy. The panel discussion focused on a few key questions, the responses to which are summarized below.

What is the impact of restricting California oil production on the global oil market?

Restricting California oil production would likely result in a slight increase in the global price of oil. Any policy that increases the price of oil could incentivize additional oil exploration and extraction, potentially increasing the non-California supply of oil. The overall impact of a reduction of California oil production on the global oil supply, however, is uncertain and dependent on many variables including the response of oil suppliers to changes in oil prices.

For every barrel of oil not extracted in California, panelists identified a potential range of impacts on global oil consumption - from zero change in global consumption to a reduction of approximately 0.6 barrels for every barrel of oil not extracted in California based on supply and demand elasticity, or how the quantity of oil (supply or demand) responds to changes in price.

What are the potential costs of restricting California oil production?

The Stockholm Environment Institute estimates the average cost per tonne of GHG reductions from restrictions on California oil production could range from \$110 to \$330.⁸ This cost represents the lost profit to California oil producers – which if not forgone could be utilized to some extent to maintain investment and jobs within the state. Panelists argued that the \$110 to \$330 cost is in line with estimated costs of other measures outlined in the Scoping Plan. However, as noted by the other panelists, the higher cost-per-tonne measures in the Scoping Plan address other market failures and lead to knowledge gains and advanced technology penetration around the world.

As estimated in the Scoping Plan, the 50 percent Renewable Portfolio Standard has an estimated cost of \$175 per tonne in 2030 while the LCFS has an estimated cost of \$150 per tonne.⁹ Both of these policies, however, lead to innovation and adoption of new clean technology. Reducing California oil production would have a higher cost per tonne than any other measure in the Scoping Plan without any benefits associated with innovation or technology dissemination.

According to the calculations of one of the panelists, restricting California oil production would lead to a potential wealth transfer from global consumers to producers estimated at about \$500 per tonne.¹⁰ This wealth transfer occurs only under policies, including restriction of petroleum supply, which increase the price of oil. The wealth transfer represents the out of pocket cost of higher oil prices paid by global consumers that will go to oil producers outside of California. The wealth transfer could reduce funds for new technologies that will be required to achieve long-term climate goals – like lower cost batteries and more advanced ZEVs. For instance, CARB's Cap-and-Trade Program places a price on carbon and has generated billions of dollars that have been reinvested in projects that achieve additional GHG reductions throughout the state, with at least half of the funds achieving reductions in disadvantaged communities.

The panel also discussed the geopolitical impacts of policies that increase the price of oil. Countries in the best position to make up a decrease in California production include Saudi Arabia, Venezuela, and Russia. Political instability, in these and other oil producing countries around the globe, coupled with uncertainty in the price response of demand and supply described above, would increase the probability of global oil price volatility in the future. Policies based on influencing the price of oil would not be resilient to changing political and economic conditions, and therefore, would not provide a steady and predictable reduction in GHG emissions as could be achieved under other types of policies to reduce oil demand.

Reducing California oil production could also result in a reduction in potential emissions reductions from CCS in the oil industry. The California oil industry has infrastructure, technology, and geologic knowledge to potentially implement carbon capture and storage which will remove GHG emissions, as well as health-impacting local pollutants like oxides of nitrogen (NO_x) and sulfur oxides (SO_x), from the air. Restricting oil production in California would reduce the potential to achieve significant GHG reductions from this

8 <https://www.sei.org/publications/limiting-oil-production-california/>

9 https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf

10 <https://energyathaas.wordpress.com/2018/08/06/should-california-keep-its-oil-in-the-ground/>

technology, including removing and storing emissions that have already been emitted potentially resulting in net GHG emissions benefits. Nearly every long-term climate model shows wide-scale adoption of CCS as critical to achieve long-term global climate targets and prevent catastrophic impacts of climate change.

Restricting oil production in California could also result in costs to regional and local economies, including loss of employment and tax revenue vital to providing essential public services across the state. Panelists also discussed the importance of considering the impacts to a local labor force by eliminating high paying, skilled jobs and the need to consider the impact of a transition to other forms of employment. The political backlash seen from the decline of the coal industry – for largely economic and not policy reasons – can serve as an example of the costs to communities from a transition away from an industry that has been central to regional identities and the economy.

What are the potential benefits of restricting California oil production?

There was no consensus in the magnitude of GHG emission reductions that could result from a restriction in California oil production. There was also no consensus that a restriction of California oil production would result in GHG emission reductions that would be additional to reductions that will occur from the 45 percent reduction in fossil fuel demand modeled in the Scoping Plan. The potential magnitude of GHG emission reduction benefits from restricting California oil production relies on assumptions about the global response to changes in oil prices – which is highly uncertain and a point of debate among the panel.

The panel did agree that there are potential local air quality benefits if California oil production declines at oil wells near communities. Along with potential GHG benefits, there could be health benefits including avoided premature mortality and reduced hospitalizations due to asthma if localized air pollution is reduced due to reductions in oil production. Panelists highlighted the need to improve quantification of the localized impacts of any potential policy that restricts oil production in order to better understand the impact on human health, community vitality, regional employment, and the impact on household expenditures across California communities. Equity considerations should be a central tenant of any policy to reduce California oil production. However, the panelists also pointed out that some of the avoided environmental and health impacts may be transferred to other parts of the country and world given the state will have continued demand for oil produced elsewhere. In addition, though it is ideal for a GHG reduction policy to have such co-benefits as improved air quality, it is possible that the best solution may be through distinct policies that directly address the problem.

The panelists also discussed the potential for global benefits that could result in a restriction of California oil production. Panelists agreed that California is a climate leader and has a strong history of leading other jurisdictions to take climate action through adopting California policies including the LCFS, vehicle standards and ZEV mandates, and the Cap-and-Trade Program. However, panelists did not agree that policies to reduce California oil production would be adopted by other regions. While France and New Zealand have adopted policies to further reduce oil production, France does not produce a substantial amount of oil and New Zealand's ban is only on new offshore permits. Panelists discussed the merit of California oil reductions in the absence of similar policies from major oil producing countries like Saudi Arabia. There are potentially large benefits to global reductions in oil consumption – but the panel did not reach a consensus on the global value of a restriction in California oil production. Panelists did however highlight the continued value in exporting California policies and technologies to other regions as has been demonstrated through existing programs like the LCFS and Cap-and-Trade Program.

How can we make liquids fuels as low-carbon as possible?

The LCFS provides incentives to reduce the carbon intensity of California's liquid fuel and the incentive is resulting in innovation leading to wider global adoption of fuel policies (for instance, in Oregon and British Columbia) and clean fuel usage. There are also opportunities in the proposed LCFS amendments to combine low-carbon biofuel production with carbon storage (through CCS) in oil fields which will result in a lower carbon portfolio of transportation fuels. Current regulatory complexities have hampered CCS efforts, but the proposed LCFS provisions may lead to wider adoption of CCS, which will lead to technology and knowledge spillovers that can lead to deep reductions in the carbon intensity of fuels around the world.

Panelists also discussed the need for the LCFS to provide greater incentives for transformative low-carbon fuels rather than fuels, like corn ethanol, that only result in modest GHG reductions. The panelists agreed that more research is needed to develop technologies and transformative fuels that can be exported to other jurisdictions.

How could political uncertainty impact GHG reductions from the restriction of oil production?

The panel also discussed the need to promote policies that can withstand changes in political leadership. Any potential benefit to restricting California oil production could be affected by political uncertainty across various jurisdictions. Uncertainty in the priorities of state and federal administrations could disrupt policies that restrict California petroleum production. For instance, a moratorium on new oil drilling permits could be reversed in the future by a change in administration. Such a reversal could potentially result in greater oil production than would have occurred in the absence of the policy. Global political uncertainty, in regards to production decisions by oil producing regions could impact the price of oil which could lead to unanticipated costs or changes in GHG emission reductions assumed due to a reduction in California oil production.

Panelists reiterated the need for resilient policies that reduce the demand for petroleum in the face of geopolitical uncertainty. The panelists stressed that GHG reductions achieved through demand side policies could not be reversed by changes in administrations as they would effect real change in consumer behavior. Such a strategy relies on a continued need for innovation and technological breakthroughs along with the Scoping Plan's suite of measures to reduce demand for petroleum-based transportation fuels across the state.

Section 5: Public Comments

The workshop was attended by approximately 60 stakeholders and members of the public. Oral comments received at the workshop focused on the need to analyze the local impact of any additional policies to reduce GHG emissions from petroleum usage including regional employment impacts and environmental justice concerns.

Stakeholders also had an opportunity to submit written comments which are available for viewing at: <https://www.arb.ca.gov/lispub/comm2/bccommlog.php?listname=ghgpetroleumfuels-ws>

Section 6: Summary and Next Steps

The two panels provided an opportunity for CARB to hear experts discuss additional opportunities for GHG reductions related to the consumption and production of petroleum. While many questions were raised about potential policy options, there is a clear desire for more incentives for innovation in the transportation sector to ensure that California achieves its long-term climate targets.

While policy and technology options were raised, there was no consensus on specific policy or technology proposals that are currently cost-effective and technologically feasible in the context of Resolution 17-46 that would require revisions to the portfolio of measures outlined the Scoping Plan. There was, however, consensus across both panels for continued study of the global impacts of California's comprehensive suite of transportation policies – including impacts on global oil markets, changes in net GHG emissions and air quality impacts, innovation and technology spillovers, wealth transfers, and environmental justice impacts.

To this end, CARB will begin a new research initiative to analyze the impacts of California achieving significant reductions in petroleum consumption. The initiative will analyze (1) the California impacts of policies and actions to transition away from petroleum transportation fuels, including local air quality and economic impacts and (2) the global impact of California policies, including global oil market impacts, as well as exporting policy innovation and technologies. This multi-year research initiative will be developed in coordination with California agencies that implement policies and programs related to petroleum production and consumption including DOC, CEC, and SGC. Additional detail on this new research initiative, including opportunities for public input, will be presented by the end of the year.